IODP Proposal Cover Sheet

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Mediterranean-Atlantic Gateway Exchange

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Title	Investigating Miocene Mediterranean-Atlantic Gateway Exchange
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Keywords	Paleoclimate, marine gateway, salt giant
Area	Either side of Gibraltar Strait

Proponent Information

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Abstract

This IODP pre-proposal is part of an amphibious drilling project that aims to recover a complete record of Mediterranean-Atlantic exchange before, during and after the Messinian Salinity Crisis (MSC). This will be achieved by targeting with IODP, off-shore sediments on either side of the present day gateway, Gibraltar, and, with ICDP, recovering core from Gibraltar's two precursor connections, the Rifian and Betic corridors which are now exposed on land in Morocco and Spain. By reconstructing exchange we can investigate the role of Mediterranean overflow during a period of significant paleoclimatic change including the onset of northern hemisphere glaciation in the Late Miocene. These sediments will also allow us to explore the mechanisms for high amplitude environmental change in the Mediterranean and test physical oceanographic hypotheses for extreme high density overflow dynamics that do not exist in the world today on this scale.
Marine gateways play a critical role in the exchange of water, heat, salt and nutrients between oceans and seas. Changes in gateway geometry can therefore significantly alter both the pattern of global ocean circulation and associated heat transport and climate, as well as having a profound local impact. For the past five million years Mediterranean seawater has flowed out of the Gibraltar Straits, forming a saline plume at intermediate depths in the Atlantic that contributes to Atlantic Meridonal Overturning Circulation, and deposits distinctive contouritic sediments in the Gulf of Cadiz. However, before the Pliocene, two additional marine corridors also existed through northern Morocco and southern Spain. The restriction and closure of these connections resulted in extreme salinity fluctuations in the Mediterranean, leading to the precipitation of thick MSC evaporites. Understanding both the causes of high-amplitude salinity change in the Mediterranean and its consequences for thermohaline circulation in the Atlantic and other aspects of the global climate system, is dependent on recovering a complete record of Mediterranean-Atlantic exchange before, during and after the MSC.
Critical to our ability to target and recover this continuous record of exchange is an understanding of where the plume of water formed by Mediterranean overflow would have been in the past. The sediments recovered from IMMAGE drilling will also provide a unique opportunity to test well established ocean physics hypotheses describing the location, size and velocity of overflow plumes in situations where the density difference between Mediterranean and Atlantic water is up to two orders of magnitude greater than today.

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Scientific Objectives

The main objectives of the IMMAGE research program are:
1.To recover a complete record of Mediterranean-Atlantic exchange before, during and after the Messinian Salinity Crisis and to evaluate the causes and local, regional and global consequences of this extreme oceanographic event;
2.To document the time at which the Mediterranean first started to contribute a distinct outflow and to assess its role in triggering northern hemisphere glaciation;
3.To establish through which of the three possible conduits (Gibraltar, Rifian Corridor or Betic Corridor) exchange occurred during the Late Miocene;
4.To test our quantitative understanding of the behavior of ocean plumes under the wide range of conditions that occurred in the Late Miocene.
All four of these objectives require sediments that can only be recovered by undertaking both on-shore drilling in Morocco and Spain and offshore drilling in the Alborán Sea and on the Atlantic slope. The drilling strategy for IMMAGE is therefore amphibious.

Non-standard measurements technology needed to achieve the proposed scientific objectives

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Proposed Sites (Total proposed sites: 3; pri: 3; alt: 0; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ALB-01A (Primary)	36.1260 -1.8200	2030	660	0	660	This site targets the Late Miocene record of Atlantic inflow to the Mediterranean. Drilling is required here to test several hypotheses in both Theme 1 and Theme 2 (Table 1). It is an essential component of the principle IMMAGE objective which is to recover a complete record of Mediterranean-Atlantic exchange
GUB-01A (Primary)	36.3589 -7.6059	637	1321	0	1321	This site targets a shallow thick Miocene succession in the pathway of Mediterranean overflow. The aim is to obtain a complete, high-resolution (precessional) record of Miocene Mediterranean overflow. This record is not only a key component of the complete record of Mediterranean-Atlantic exchange (Theme 1) but also provides a test of physical oceanographic models for dense overflow systems (Theme 2). Its contribution to testing specific hypotheses associated with these two themes is shown in Table 1.
ALM-01A (Primary)	37.4317 -9.5767	1567	1821	0	1821	This site targets a thick, shallow Late Miocene succession which contains distal Mediterranean overflow deposits that capture the evolution of the equilibrium depth of the plume and hence tests quantitative constraints on the behavior of dense overflows (Theme 2). The high resolution (precessional) record is a key component of the complete record of Mediterranean-Atlantic exchange during the Late Miocene-Pliocene (Theme 1). This site's contribution to testing hypotheses associated with both themes is shown in Table 1.